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Growth of Postlarval Atlantic Silversides in Four Temperature Regimes

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16. ABSTRACT

Fourteen-day-old Atlantic silvesides were exposed over a period of four weeks to four different constant or cyclic temperature regimes. The four regimes used were: "ambient"(A) - ambient temperature (17.8 to 21.9°C) throughout the experiment; "heated"(H) - 8±1°C above ambient throughout the experiment; "ambient1,heated 2" (H1,A2) - ambient during weeks 1 and 3, 8±1°C above ambient during weeks 2 and 4;and "heated 1, ambient 2" (H1,A2) - 8±1°C above ambient during weeks 1 and 3, ambient during weeks 2 and 4.

Measurements of growth (wet weight) made during this period suggest that Atlantic silversides hatching in the warmer waters of upper marsh and tidal rivers would grow at a greater rate, other things being equal, than fish hatching in colder Narragansett Bay waters. Faster growth would appear to be an adaptive advantage since it would reduce the time that the fish are most susceptible to predation and also enable them to begin ingesting larger prey organisms earlier. Whatever the natural advantage may be, rearing of silversides at 26-29°C would be advantageous for the aquaculturist.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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Growth of Postlarval Atlantic Silversides in Four Temperature Regimes[1]

The Atlantic silverside (*Menidia menidia*) is an important forage fish for commercial fish species in coastal areas of eastern North America from Prince Edward Island to Florida. It is also of considerable importance as a test organism in toxicity tests (Voyer et al. 1979; Middaugh and Dean 1977).

Hoff and Westman (1966), Gift (1970), and Austin et al. (1975) have investigated the effects of short-term temperature changes on Atlantic silversides. No long-term studies of elevated temperature on Atlantic silversides have been done.

Adult Atlantic silversides in Rhode Island are most commonly found in the upper reaches of salt marshes and tidal rivers during the spawning period from April to June (Bengtson, unpublished data). During this time, water temperatures are about 4-8°C warmer than the water in Narragansett Bay. Since newly hatched fish may be exposed to such a wide range of temperatures, we measured weekly growth of postlarval and juvenile silversides at ambient Narragansett Bay water temperatue, at ambient plus 8°C, and in water fluctuating between ambient and ambient plus 8°C. The data reported here have significance for the culture of Atlantic silversides for bioassay studies.

Gravid silversides from Washington County, Rhode Island, were stripped and artificially fertilized and embryos were incubated on nylon screens in large hatching jars. Hatchlings were fed ad libitum on newly hatched brine shrimp nauplii (*Artemia*, Macau, Brazil, strain) and maintained at ambient temperature (18.5 to 19.2°C) until the start of the experiment.

Twenty-eight days after fertilization, 14-day-old fish were stocked into four experimental aquaria (165 L) at a density of 200 per aquarium. Each aquarium received a constant supply of filtered Narragansett Bay seawater (0.5 L/min), was gently aerated, and contained a 1,000-W immersion heater. The four temperature regimes used were ambient (A) - ambient temperature (17.8 to 21.9°C) throughout the experiment; heated (H) - 8 ± 1°C above ambient throughout the experiment; ambient 1, heated 2 (A1, H2) - ambient during weeks 1 and 3, 8 ± 1°C above ambient during weeks 2 and 4; and heated 1, ambient 2 (H1, A2) - 8 ± 1°C above ambient during weeks 1 and 3, ambient during weeks 2 and 4.

Twenty fish were removed from each aquarium each week for measurements of total length and wet weight. Statistical treatment of the data was by analysis of variance, followed by the Student-Newman-Keuls a posteriori test (Zar 1974). The level of significance was accepted as being $P \leq 0.05$.

Fish were fed brine shrimp nauplii (Macau strain) four times daily and all aquaria received equal amount of food. Size of the food ration was recalculated each week on the basis of largest mean weight obtained from the 20-fish samples. During the first 2 weeks the ration was 200% of the largest mean body weight per day on a wet-weight basis. Because of limitations on brine shrimp production, this was reduced to 100% and 55% during the third and fourth weeks, respectively. Actual amount fed was determined by multiplying calculated ration size by a factor of 1.14 to allow for food washed out of the flow-through system.

Water heated to 8°C above ambient had a strong positive effect on growth of Atlantic silversides (Table 1). Gain in wet weight was greater during periods of exposure to heated water than during periods of exposure to ambient water (Fig. 1). After 4 weeks, fish maintained in seawater at 8°C above ambient throughout the experiment had 178% greater growth in wet weight than fish maintained at ambient temperature. Fish in the two aquaria with fluctuating temperatures

Table 1. Total lengths[a] in millimeters (upper number) and wet weights in milligrams (lower number) for fish in the four treatments at the end of each week of the experiment. At the beginning of the experiment, average total length was 10.39 ± 0.84 mm and average wet weight was 3.26 ± 1.18 mg.

Week	Treatment			
	Ambient 1–4	Heated 1–4	Heated 1,3 Ambient 2,4	Heated 2,4 Ambient 1,3
1	11.98(0.25)	13.02(0.28)	12.25(0.30)	11.56(0.29)
	5.85(0.50)	8.39(0.62)	6.92(0.59)	4.86(0.52)
2	14.93(0.38)	18.28(0.40)	16.29(0.42)	15.96(0.55)
	13.12(1.00)	29.16(2.10)	19.84(1.68)	18.94(1.98)
3	18.12(0.41)	23.33(0.72)	20.84(0.44)	20.23(0.40)
	24.49(1.61)	66.53(6.44)	43.01(2.84)	36.56(2.54)
4	21.59(0.64)	28.40(0.72)	25.41(0.55)	25.48(0.57)
	48.16(4.07)	127.96(10.02)	85.75(6.63)	86.16(6.11)

[a] Average (± SE, given in parentheses).

[1] Contribution No. 180 from the Environmental Research Laboratory, Narragansett, R.I.

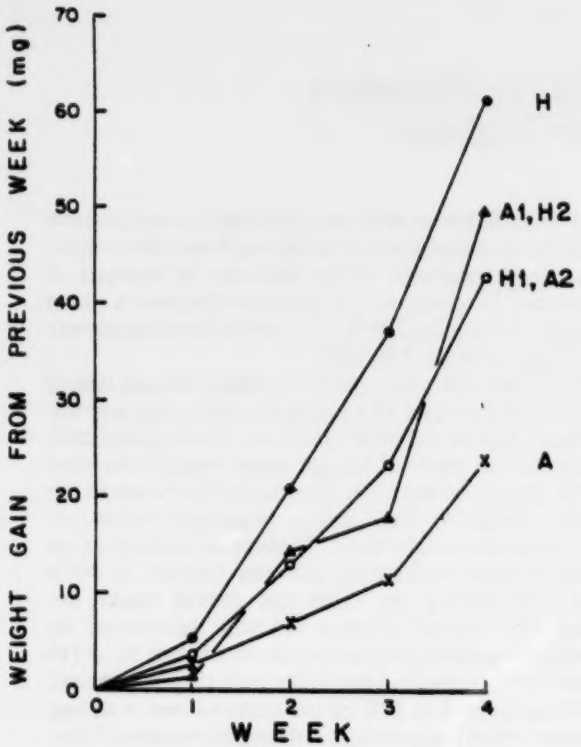

Fig. 1. Average wet weight gain (in milligrams) for fish in each aquarium during each week. H = heated during all four weeks; A = ambient during all four weeks; H1, A2 = heated during weeks 1 and 3, ambient during weeks 2 and 4; A1, H2 = ambient during weeks 1 and 3, heated during weeks 2 and 4.

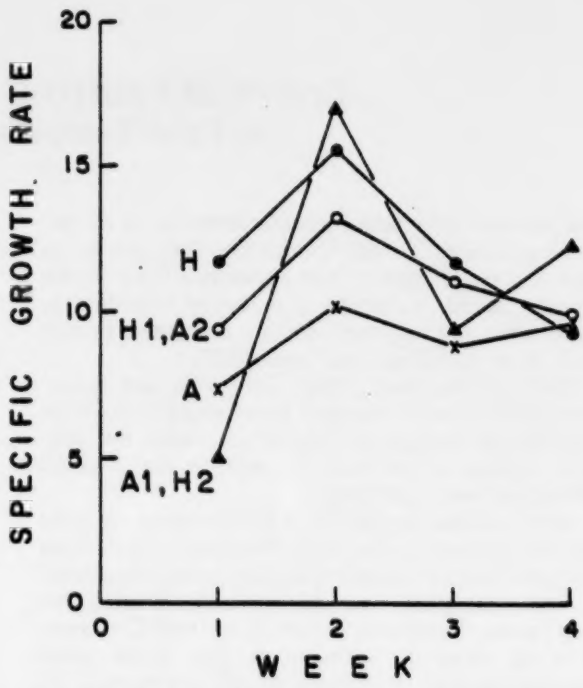

Fig. 2. Specific growth rate for fish in each aquarium during each week. (See Fig. 1 caption for explanation of symbols.)

had equal growth after 4 weeks, 84% greater than fish maintained at ambient temperature. Significant differences existed between mean wet weights of fish in all aquaria, except those with fluctuating temperatures, after 2 weeks of treatment.

In view of these results, it is expected that Atlantic silversides hatching in the warmer temperature waters of upper marsh and tidal rivers would grow at a greater rate, other things being equal, than fish hatching in colder Narragansett Bay waters. Faster growth would appear to be an adaptive advantage since it would reduce the time that the fish are most susceptible to predation and also enable them to begin ingesting larger prey organisms earlier. Whatever the natural advantage may be, rearing of silversides at 26–29°C would be advantageous for the aquaculturist.

An important aspect of silverside growth was noted when specific growth rate, $[(\ln w_1 - \ln w_0/(t_1 - t_0)] \times 100$ (where w_1 and w_0 are wet weights at times t_1 and t_0, respectively), was plotted against time (Fig. 2). Fish in each treatment showed a greater specific growth rate during week 2 than during any other week. Since this increase occurred regardless of environmental influence, it is interpreted as a genetically programmed developmental event, probably associated with the transition from postlarval to juvenile stages that occurred during this time. It would be useful to know whether food intake or food conversion efficiency also increased dramatically at this time so that an optimal level of food could be given to cultured fish during this important period of rapid growth.

In conclusion, our data show that a tremendous increase in growth is obtained by rearing Atlantic silversides at temperatures characteristic of shallow marshes rather than those of open bay waters. Researchers culturing this species at 26–29°C for toxicological bioassays will produce experimental animals whose daily growth rate more closely approaches that of field fish (0.84 mm/day; Barkman et al., in press) than does that of fish reared at 18–21°C.

References

Austin, H.M., A.D. Sosnow, and C.R. Hickey, Jr. 1975. The effects of temperature on the development and survival of the eggs and larvae of the Atlantic silversides, *Menidia menidia*. Trans. Am. Fish. Soc. 104(4):762–765.

Barkman, R.C., D.A. Bengtson, and A.D. Beck. In press.

Daily growth of juvenile *Menidia menidia* in the natural habitat compared to those reared in the laboratory. *In* K. Sherman and R. Lasker, eds. Early Life History of Fish II. Rapp. P.-v. Reun Cons. Int. Explor. Mer 178.

Gift, J.J. 1970. Responses of some estuarine fishes to increasing thermal gradients. Ph.D. thesis, Rutgers University. New Brunswick, N.J. 187 pp.

Hoff, J.G. and J.R. Westman. 1966. The temperature tolerances of three species of marine fishes. J. Mar. Res. 24(2):131–140.

Middaugh, D.P., and J.M. Dean. 1977. Comparative sensitivity of eggs, larvae and adults of the estuarine teleosts *Fundulus heteroclitus* and *Menidia menidia* to cadmium. Bull. Environ. Contam. Toxicol. 17(6):645–652.

Voyer, R.A., J.K. Heltshe, and R.A. Kraus. 1979. Hatching success and larval mortality in an estuarine teleost, *Menidia menidia* (Linnaeus), exposed to cadmium in constant and fluctuating salinity regimes. Bull. Environ. Contam. Toxicol. 23(4/5):475–481.

Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Englewood Cliffs, New Jersey.

—David A. Bengtson, *U.S. Environmental Protection Agency, Environmental Research Laboratory, Naragansett, R.I. 02882,* and Robert C. Barkman, *Biology Department, Springfield College, Springfield, Mass. 01109.*

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Pelletized Diet for Rock Crabs

Although interest in the study of crustacean ecology, behavior, and physiology has recently increased, few commercial diets are available for maintenance of crustaceans in the laboratory. Bardach et al. (1972) suggested that a pelletized feed should be developed for use with crustaceans.

Study of the common rock crab (*Cancer irroratus*) in a recirculating laboratory system requires a diet that would enable the crabs to live for extended periods and to survive molting. The objectives of this study were to develop a diet that would provide nutrients at relatively low cost, that could easily be manufactured, stored, and handled, and that would be accepted by the crabs and resistant to disintegration.

To minimize differences in temperature and water quality, all crabs tested were kept in the same recirculated sea water. Water temperature was maintained between 10 and 15°C in a 945-L testing facility, serviced by both biological and mechanical filters. Levels of ammonia, nitrite, nitrate, pH, dissolved oxygen, and salinity were monitored every other week; 10% of the artificial sea water (average salinity, 31‰) was changed monthly to prevent buildup of nitrogenous waste products. All crabs used in the diet study were also being monitored for daily and tidal rhythms of locomotor activity by infrared beams and photocells, a method that did not influence feeding behavior. Activity tests took place over a period of 3 years, and the photoperiod was changed for each such test. A more complete description of the activity testing procedure and apparatus was reported by Rebach (1977).

In 31 activity tests, 20 to 50 crabs were fed three different diets. Diet 1 consisted of beef (21% protein) cubes about 1 cm^3, each weighing about 0.5 g; the cubes were kept frozen until the day of use. Diet 2 was a commercial flake or chip-shaped feed (Purina Marine Ration, 30% protein; about 40 flakes per gram) that has been used in shrimp mariculture. Diet 3 was a pellet diet, prepared by mixing all the ingredients listed in Table 1, except the gelatin, for 30 min in an electric mixer; 250 g of gelatin stirred in 1 L of boiling water

Table 1. Ingredients of pelletized diet for rock crabs.

Ingredient	Amount (g/kg, dry wt)	Ingredient	Amount (g/kg, dry wt)
Fish meal	250	Crab meal	45
Ground yellow corn meal	250	Alfalfa	30
Soybean meal	150	Bone meal	15
Wheat bran	50	Vitamin pre-mix[a]	10
Wheat middlings	50	Menhaden fish oil	50
Corn fermentation solubles	50	Gelatin	50

[a] Composition of vitamin premix expressed as milligrams of concentration per kilogram of finished feed except where otherwise indicated: vitamin B_{12}, 5.4; vitamin K, 1,800; riboflavin, 2,700; niacin, 22,700; pantothenic acid, 4,500; pyridoxine, 910; folic acid, 360; selenium, 41.2; vitamin A, 2,300,000 IU; vitamin D_3, 900,000 IU; vitamin E, 2,300 IU.